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ABSTRACT

Research on abstract categorical reasoning has shown that students with "A" grade point averages (GPA) have limited, better and often less, reasoning ability than students with lower GPA's. A similar effect was also found when testing "bright" and "dull" subjects. An analysis of this effect was conducted using the component model of categorical reasoning. Findings indicated that most subjects employed either basic or advanced reasoning, but not complete reasoning. In the standard instruction condition, high GPA students were less likely than low GPA students to employ a complete reasoning strategy. In the 50% instruction condition, high GPA students were more likely than low GPA students to employ a complete reasoning strategy. Results suggest that the failure or success of research in this area may be dependent on exactly what problems are used by the investigator and the exact form of the instructions given to the subjects. (Author/KMF)

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Grade Point Average and Reasoning Ability

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CG 014992

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Grade Point Average and Reasoning Ability

The study that I will talk about today is concerned with the relation between students' reasoning ability and their grade point averavge (GPA). In the course of doing research on abstract categorical reasoning we have repeatedly observed that "A" students are seldom better and often times worse reasoners than students with lower GPA's. This has been especially true of performance on Invalid problems--problems for which no unambigious conclusion can be drawn. The following figure shows this effect

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Insert Figure 1 about here

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in several different experiments that we have conducted.

A review of the literature reveals that in 1936 Sells found a similar effect when testing what he called "Bright" and "Dull" subjects. The purpose of the present study is to provide an analysis of this effect in terms of the Component Model of categorical reasoning (Leirer and Revlin, 1977). Before discussing the present study, I will give a brief description of abstract categorical syllogisms and the Component Model of categorical reasoning.

Abstract, categorical reasoning was formalized more than 2,000 years ago by Aristotle. Categorical reasoning has at least three properties that make it useful in the investigation of human inference. First, it is a well defined task domain. The following is an example of the type of problem we use. It contains a Major premise, a Minor premise, and five possible conclusions. The Major and Minor premises share a common or Middle term. In this example, the term is B.

Insert Figure 2 about here

The next diagram shows the four possible arrangements of the common

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Insert Figure 3 about here

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term in a two premise syllogism. Finally, all premises are constructed using one of four quantifiers. These are shown in Euler diagram form in Figure 4. As shown, All means each and every, No means none, Some means

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Insert Figure 4 about here

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at least one and possible all, and Some are not means at least one is not and possible none are.

A second usefull feature is that certain other forms of reasoning may be interpreted as limited instances of categorical reasoning. For example, linear orderings, a common form of reasoning, is typified by the assertion B is greated than A. This assertion may be thought of as a limited interpretation the universal assertion, All A are B. In this special case, only the second Euler diagram interpretation of All A are B is considered by reasoners (see Figure 4).

Perhaps more important than either of the previous advantages is that categorical reasoning problems have the capability of expressing the ambiguity and complexity of reasoning tasks in the real world. For instance, the previous example problem is shown in concrete form in Figure 5.

Insert Figure 5 about here

In the abstract form we have found that over 90% of our university students select the conclusion shown here as the correct answer. The problem is invalid however, and the relation between migrant farm workers and welfare recipients is ambigious. It is incorrect to draw the conclusion that all or for that matter, any farm workers are welfare recipients. Let us now turn to the Component Model of categorical reasoning.

Previous studies have shown the Component Model to effectively predict: a) reasoning accuracy to a variety of problem types, b) shifts in reasoning complexity, and c)individual reasoner's responses (Leirer and Revlin, 1977: Leirer and Dawes, 1980). In addition, a computer simulation of the Component Model has been completed and has led to reaction time studies that provide evidence for specific cognitive processes described by the model (Leirer, Dawes, and Hopkins, 1978).

In brief, the Component Model claims that because of processing limitations most reasoners employ two reasoning heuristics. First, reasoners use a single, symmetric interpretation of each of the possible premises. For example, rather than interpreting the premise, All A are B, to mean both that A could be a subset of B and that A and B could be identical sets, reasoners limit their interpretation to the single, symmetric relation that A and B are identical sets. The second heuristic employed by most reasoners is to consider only one possible integration of the Major and Minor premise once they have been encoded.

The Component Model embodies three increasingly more complex forms of reasoning. These are shown in Figure 6. First, there is the Basic

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Insert Figure 6 about here

Reasoner who employs a single, symmetric interpretation of the premises and a single integration of the two interpreted premises. Thus, the Basic Reasoner employs both heuristics. Second, is the Advanced Reasoner who employs the single interpretation heuristic but tests for multiple and possibly contradictory conclusions. Finally, there is the perfectly logical or Complete Reasoner who employes a complete interpretation of the premises and then tests for multiple, contradicting integrations of the premises.

As a result of these differences, the three types of reasoners are claimed to draw different conclusions to each of several types of syllogisms. In terms of the present study, one relevant claim of the Component Model is that for some syllogisms, Basic and/or Advanced Reasoning produce a conclusion that is consistent with Complete reasoning. Thus, even though Basic and Advanced reasoning is incomplete, it can produce the correct conclusion. For other syllogisms, however, Basic and/or Advanced reasoning produce conclusions that are inconsistent with Complete reasoning. In the present study, syllogisms were specifically selected on the basis of this claim.

The experiment that I will now describe is the latest of several experiments investigating the reasoning performance of High and Low GPA students. This experiment replicates and extends the findings of our previous studies. The experiment was designed so that High and Low GPA students were given Standard instructions that included the meaning of the quantifiers All, No, Some and

Some are not as well as an explanation of invalid problems. A second group of High and Low GPA students were given the Standard instruction plus the additional information that 50% of the problems were invalid.

All subjects solved the same set of abstract syllogisms. Randomly distributed among these problems were Valid and Invalid test problems. Both Valid and Invalid test problems were of two types. These we will term Consistent and Inconsistent problem types. Consistent problems are those where Basic and/or Advanced reasoning results in a conclusion that is consistent with Complete reasoning. Inconsistent problems are those where Basic and/or Advanced reasoning results in a conclusion that is inconsistent with Complete reasoning. To summarize the design, there were High and Low GPA students, given either Standard or 50% instructions, who solved both Valid and Invalid syllogisms that were either Consistent or Inconsistent problem types.

The results of the experiment were analyzed in terms of the percent of correct responses to Consistent and Inconsistent problem types. While there were several findings of interest, two are of particular importance to our present investigation. First, as shown in the following figure, there was a very strong effect of problem type. Reasoners in all conditions showed a higher percent of correct responses to Consistent Problems than to Inconsistent problems, $F(1,54)=140.17, p<.01$.

Insert Figure 7 about here

This result is in agreement with our previous findings that most people employ either Basic or Advanced reasoning and not Complete reasoning.

The second finding of interest was a higher order interaction. GPA interacted with Instruction Set for the Inconsistent problems, $F(1,51)=6.45, p<.05$, but not for Consistent problems. The following figure shows the GPA by Instruction Set interaction for Inconsistent Problems. Stated simply, this interaction indicates that in the Standard instruction condition, High GPA students are less likely

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Insert Figure 8 about here

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to employ a Complete reasoning strategy than Low GPA students, but in the 50%

instruction condition High GPA students are more likely to employ a Complete reasoning strategy than Low GPA students. For Consistent problems no such interaction occured. In fact, neither GPA nor Instruction Set influenced performance on Consistent problems.

We think that these results may help to clarify several decades of ambiguious findings concerning the relation between intellectual performance and reasoning ability. Since very early research by Wilkins (1928), Sinclare and Tolman (1933), and others, there have been reports of both success and failure in finding a correlation between intellectual performance and reasoning ability. The results of the present study suggest that the failure or success of research in this area may depend, at least in part, on exactly what problems are used by the investigator and the exact form of the instructions given to the subjects. In the present study, both of these variables affected reasoning performance of High and Low GPA students.

One final note of caution concerning the results of the present study should be mentioned. While significant, the absolute effects of GPA were really quite small. By far, the most powerful variable affecting reasoning performance was the type of problem solved. As predicted by the Component Model, performance is high for problems where Basic and/or Advanced reasoning result in a conclusion consistant with Complete reasoning. For problems where only Complete reasoning produces the correct conclusion, performance is poor.

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FIGURE 1.

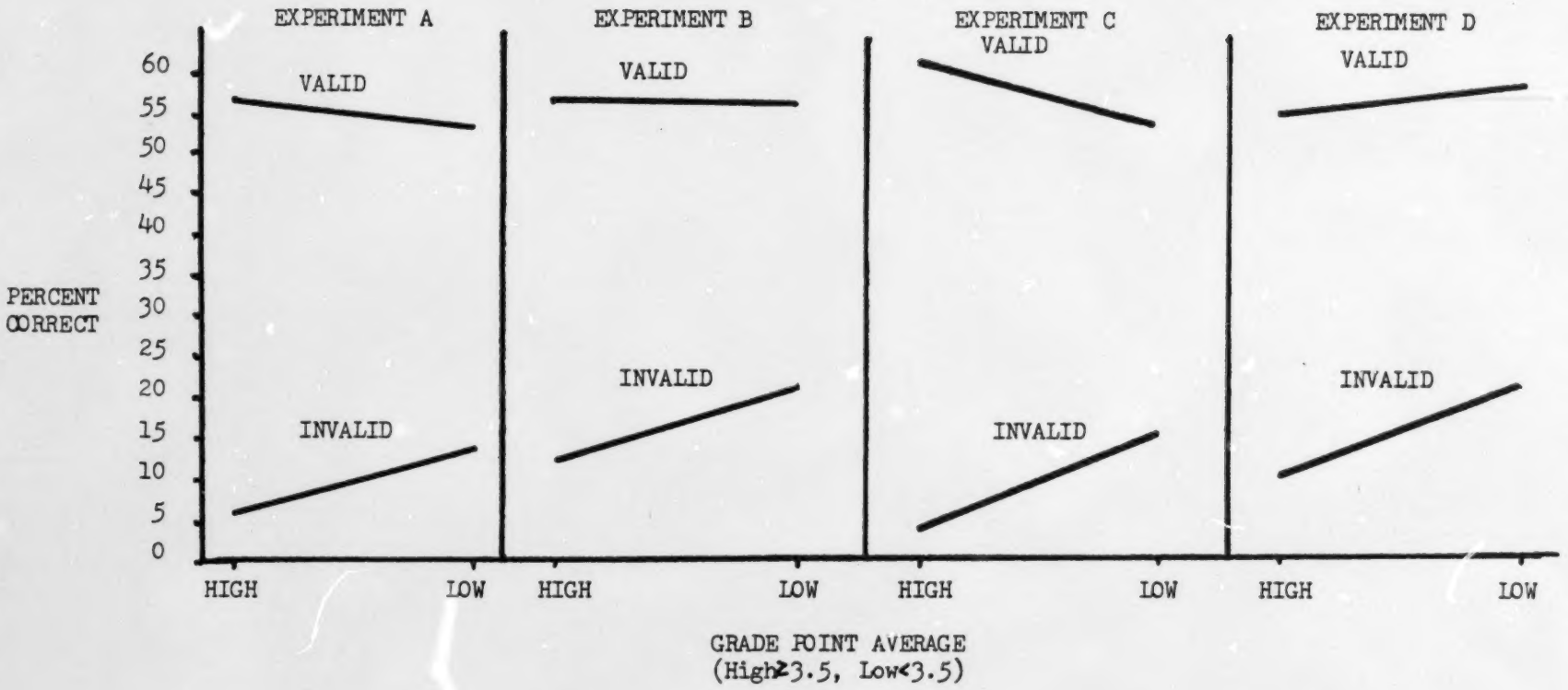

EXPERIMENT A
EXPERIMENT B
EXPERIMENT C
EXPERIMENT D
VALID
VALID
VALID
VALID
INVALID
INVALID
INVALID
INVALID
60
55
50
45
40
35
30
25
20
15
10
5
0
PERCENT CORRECT
HIGH
LOW
HIGH
LOW
HIGH
LOW
HIGH
LOW
GRADE POINT AVERAGE
(High≥3.5, Low<3.5)

FIGURE 2.

All C are B (Major premise)
All A are B (Minor premise)

Therefore:

1) All A are C
2) No A are C
3) Some A are C
4) Some A are not C
5) None of the above relations are conclusively proven.

FIGURE 3.

Figure 1	Figure 2
B-C	C-B
A-B	A-B

Figure 3	Figure 4
B-C	C-B
B-A	B-A

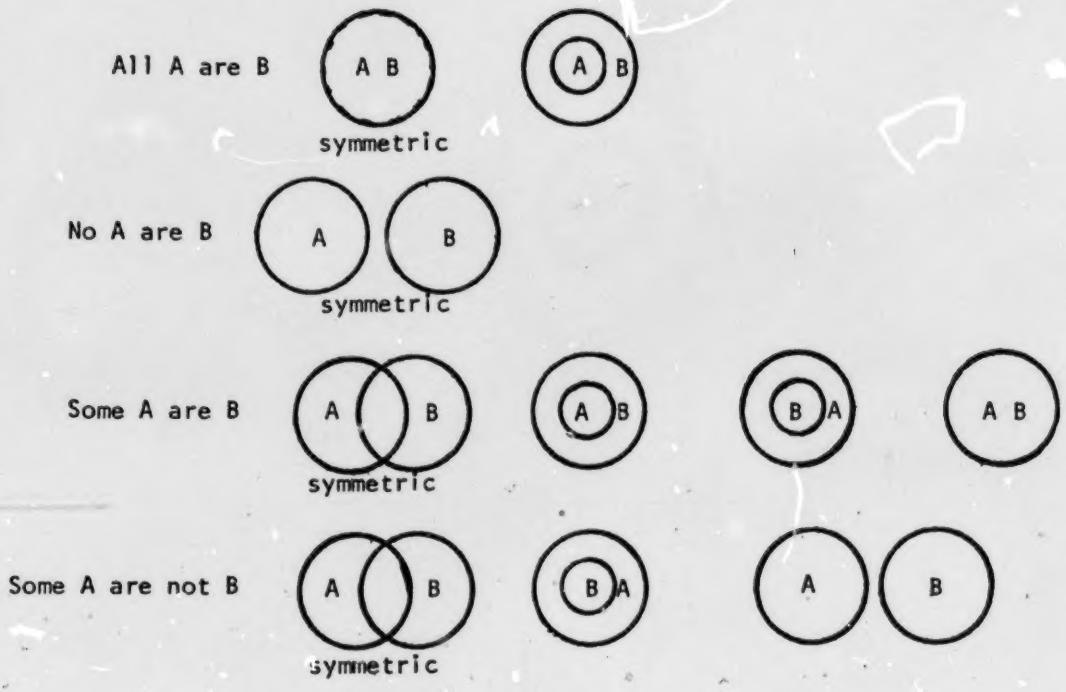


Figure 4. The possible interpretations of the four categorical premises. The first interpretation expresses a symmetric relationship between the two sets A and B.

FIGURE 5.

All welfare recipients are poor
All migrant farm workers are poor

Therefore:

All migrant farm workers are welfare recipients

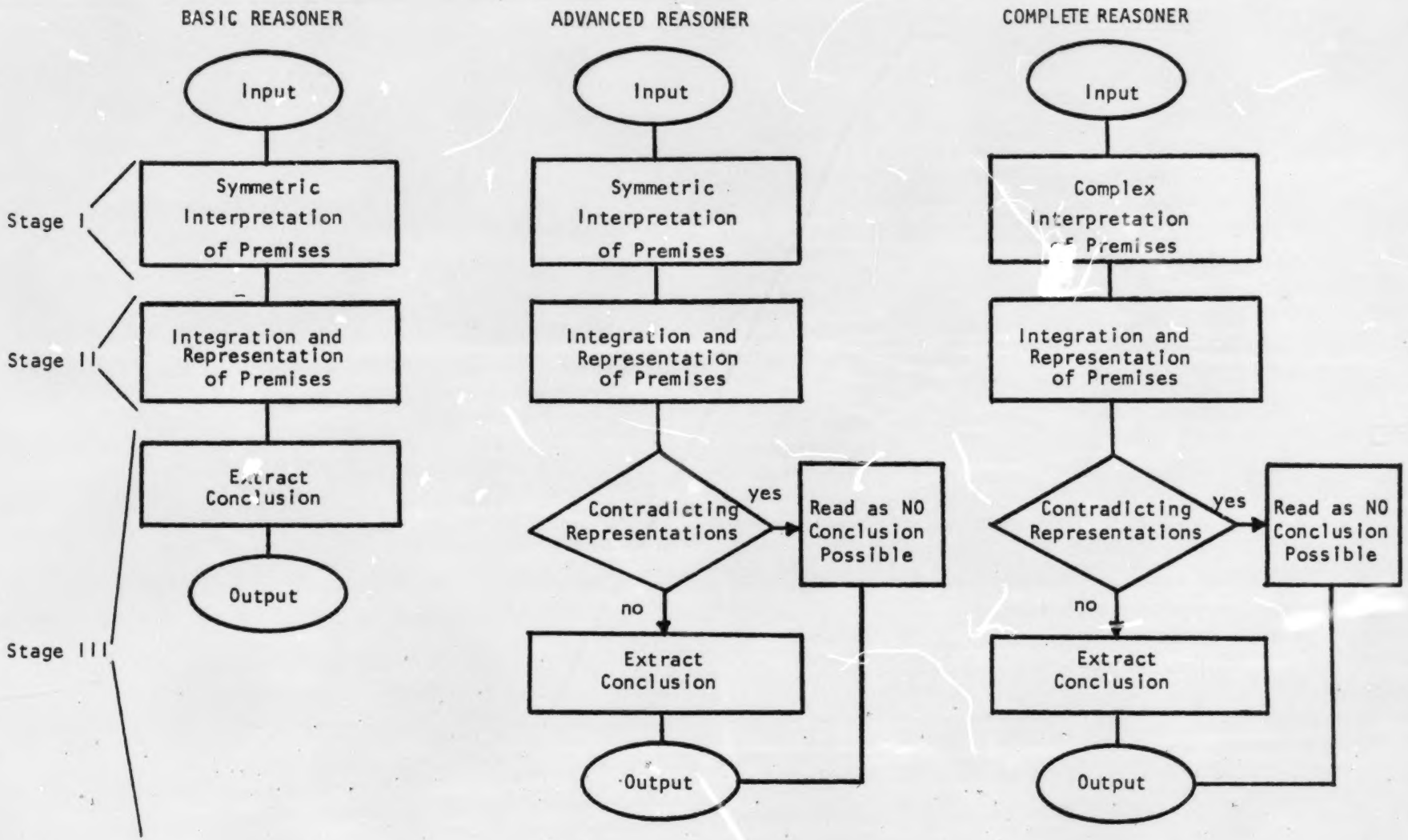


Figure 6. The three forms of the Component Model.

FIGURE 7.

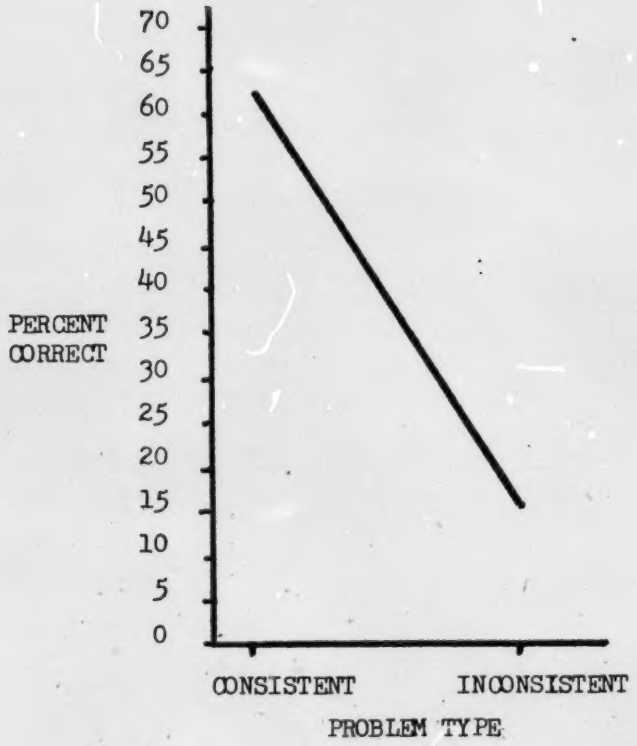
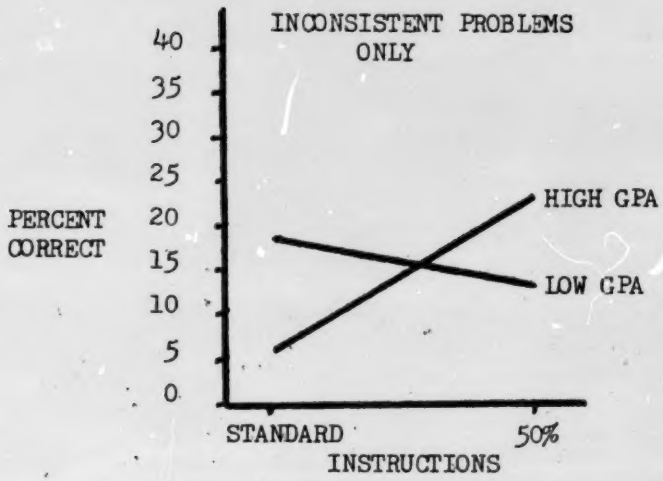

70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
PERCENT CORRECT
CONSISTENT
INCONSISTENT
PROBLEM TYPE

FIGURE 8.


INCONSISTENT PROBLEMS ONLY
40
35
30
25
20
15
10
5
0
PERCENT CORRECT
HIGH GPA
LOW GPA
STANDARD
50%
INSTRUCTIONS